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Implantation and Bio-Effects Assessments of Injectable JSATS Acoustic Transmitters

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Outline

- Background
- Objectives
- Implantation Technique
- Injectable AT Designs
- Injectable AT Testing
- Results

Background

- **Current technique for biotelemetry and survival studies in the basin is surgical implantation into the coelomic cavity**
  - Extensive handling
  - Induction Stage 4 anesthesia
  - Requires incisions 5-7 mm
  - Insertion of 2 tags
    - JSATS acoustic transmitters (AT)
    - Passive integrate transponders (PIT)
  - Requires 2 sutures
  - Overall time per fish: 4.5 - 10 min

- ***Invasive "surgical" technique***

Objectives

- Provide guidance to the JSATS downsize design:
  - Size range
  - AT meets biological objectives
- Develop implantation procedure to:
  - Minimize time required and bio-effects
  - Retain or increase retention of AT/PIT

Implantation: PIT Injections

- Intra-coelomic PIT tag injections
  - Injection site
  - No sutures
  - Reduced
    - handling and anesthetic exposure
    - risk of tag loss
    - risk of infection
    - healing time
    - implantation time
- Reduced risk to fish and projects

Implantation: PIT Design

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- PIT design

PIT Length (mm)	PIT Weight (±0.005 g)	PIT Outer Diameter (mm)	Needle Gauge (GA)
8.4	0.33	1.4	14
9-12.5	0.08-0.1	2.1	12 ★
22-32	0.6-0.8	3.65	6

- Established Protocols
  - http://www.ptagis.org more specific to salmon and Columbia Basin

Implantation: Needle Gauges

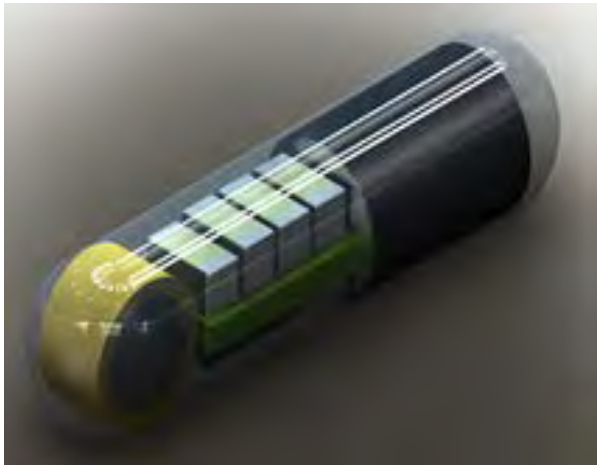
- PIT OD
  - 3.6 mm
  - 6 GA: 5.16 mm OD, 4.39 mm ID

Photo By M Halvorsen

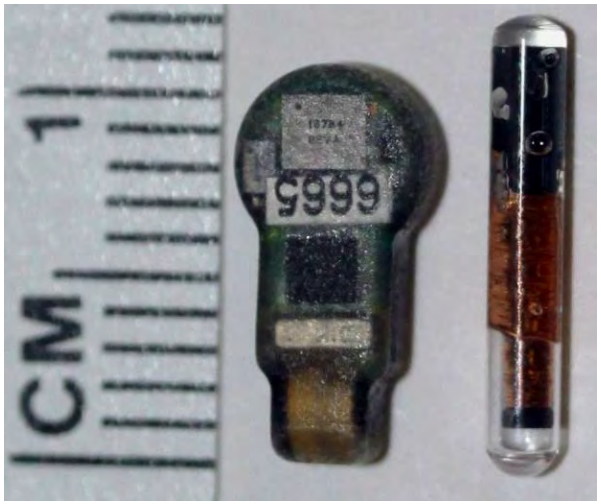
	Fish	AT Limitations	
Needle Gauge	**Outer Diameter (mm)**	**Inner Diameter (mm)**	**JSATS AT Diameter (mm)**
12	2.77	2.16	2.08
9	3.75	2.99	2.91
8	4.19	**3.42**	3.34

AT Designs

- Proposed AT Designs
  - 15.0 mm length x 3.4 mm OD
  - 12.2 mm length x 3.2 mm OD
  - 14.2 mm length x 3.0 mm OD



- Current single battery AT
  - 10.8 mm length
  - 5.3 mm width
  - 3.4 mm height

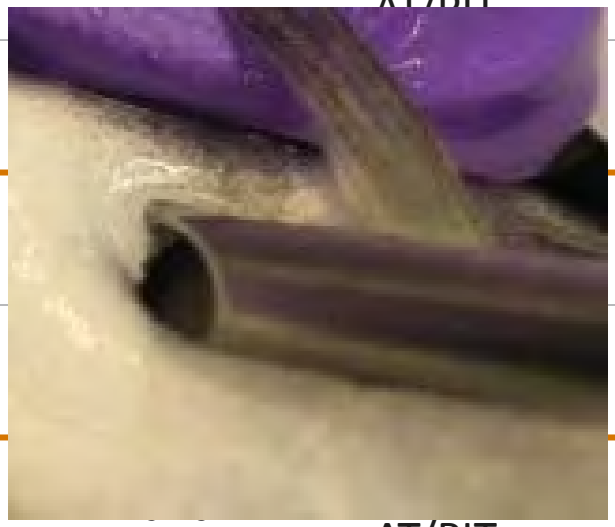


AT Assessments

- Factors assessed for acceptance and recommendation were:
  - Survival of fish: Day 0-14
  - Tag retention: Day 0-14
  - Implantation time: Day 0
  - Wound healing: Day 0, 7, 14
  - Internal damage, encapsulation: Day 14
- Factors were:
  - Assessed within and between experiments
  - Ranked by a performance index

AT Designs: Experiments

	AT Design (mm)	Incision Method	Bevel Insertion	Tag Insertion	Tag(s) Implanted	N
1	3.4 mm OD x 15 mm	8GA Needle	75%	Injection	AT	30
					AT/PIT	30
		Ocular Scalpel	NA			30
						30
2	3.2 mm OD x 12.2 mm	8GA Needle	50%			30
						30
		8GA Needle	30%			30
						30
3	3.0 mm OD x 14.2 mm	9GA Needle	~100%			30
					AT/PIT	30
		8GA Needle	50%	Injection	AT	30
					AT/PIT	30
	Each exp. included	12GA	75%	Injection	PIT	30
		CONTROL	NA	NA	-	30



Results: Survival

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AT Design Exp.	Incision Method	Bevel Insertion	Tag Insertion	Tag(s) Implanted	Survival %
3.4 mm OD x 15 mm	8GA Needle	75%	Injection	AT	100
				AT/PIT	100
	Ocular Scalpel	NA	Hand	AT	100
				AT/PIT	100
3.2 mm OD x 12.2 mm	8GA Needle	50%	Injection	AT	100
				AT/PIT	100
	8GA Needle	30%	Hand	AT	100
				AT/PIT	100
3.0 mm OD x 14.2 mm	9GA Needle	~100%	Hand	AT	100
				AT/PIT	100
	8GA Needle	50%	Injection	AT	100
				AT/PIT	100
HPT12 PIT	12GA Needle	75%	Injection	PIT	100

Results: Tag Retention

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AT Design Exp.	Incision Method	Bevel Insertion	Tag Insertion	Tag(s) Implanted	Retention %
3.4 mm OD x 15 mm	8GA Needle	75%	Injection	AT	100
				AT/PIT	100
	Ocular Scalpel	NA	Hand	AT	100
				AT/PIT	100
3.2 mm OD x 12.2 mm	8GA Needle	50%	Injection	AT	100
				AT/PIT	100
	8GA Needle	30%	Hand	AT	100
				AT/PIT	100
3.0 mm OD x 14.2 mm	9GA Needle	~100%	Hand	AT	100
				AT/PIT	100
	8GA Needle	50%	Injection	AT	100
				AT/PIT	100
HPT12 PIT	12GA Needle	75%	Injection	PIT	100

Results: Implantation Time

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AT Design Exp.	Incision Method	Bevel Insertion	Tag Insertion	Tag(s) Implanted	Impl'n Time (s)
3.4 mm OD x 15 mm	8GA Needle	75%	Injection	AT	24.9 ★
				AT/PIT	31.1 ★
	Ocular Scalpel	NA	Hand	AT	35.8 ★
				AT/PIT	46.2
3.2 mm OD x 12.2 mm	8GA Needle	50%	Injection	AT	18.6 ★
				AT/PIT	26.5
	8GA Needle	30%	Hand	AT	17.9 ★
				AT/PIT	23.8
3.0 mm OD x 14.2 mm	9GA Needle	75%	Hand	AT	19.3 ★
				AT/PIT	25.0
	8GA Needle	50%	Injection	AT	19.4 ★
				AT/PIT	28.9
HPT12 PIT	12GA Needle	75%	Injection	PIT	20.0

Results: Implantation Time

8 GA AT
Hand 30%

12 GA PIT | 9 GA AT

9 GA AT/PIT | 8 GA AT

8 GA AT/PIT | Scalpel AT | Scalpel AT/PIT

20 s | 24 s | 32 s

3.0 mm | 3.0 – 3.4 mm | 3.2 – 3.4 mm

-Surgeon handling of needle
-Pressure placed on fish flank
-Surgeon handling of tags

Results: Wound Extent, Day 14

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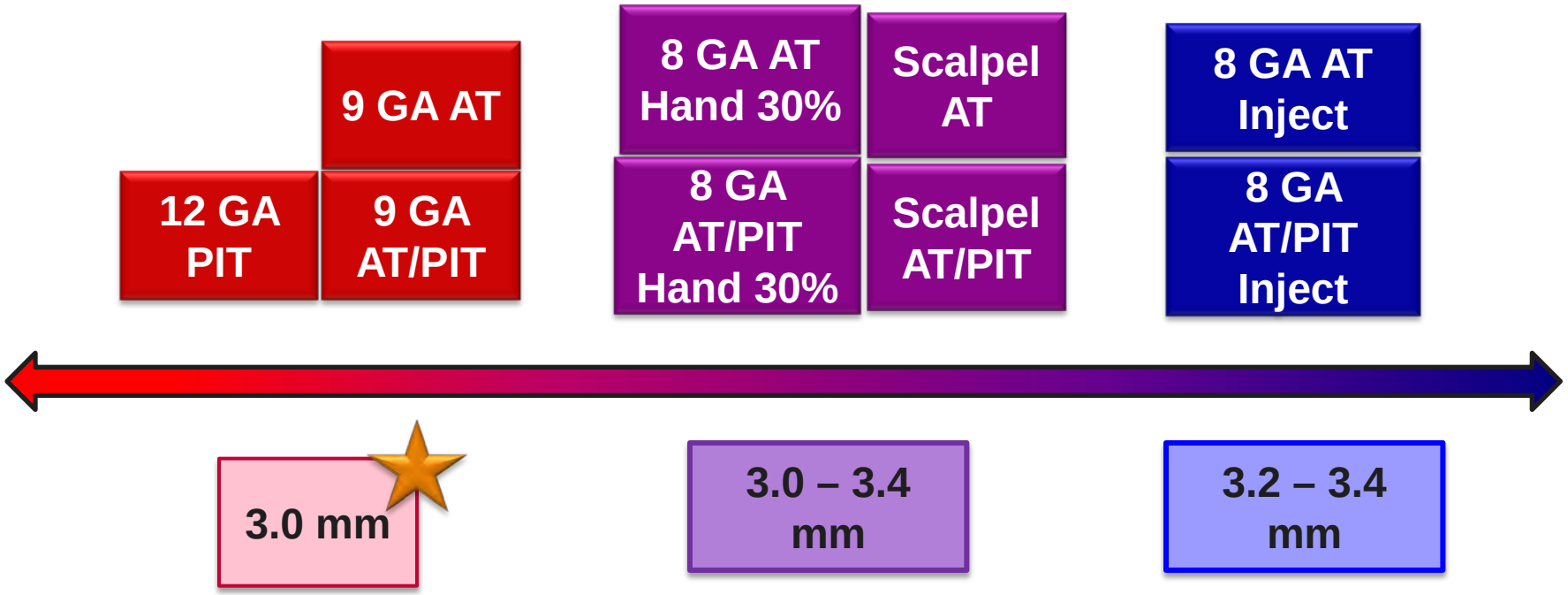
AT Design Exp.	Incision Method	Bevel Insertion	Tag Insertion	Tag(s) Implanted	Wound Extent (mm^2)
3.4 mm OD x 15 mm	8GA Needle	75%	Injection	AT	5.56
				AT/PIT	5.65
	Ocular Scalpel	NA	Hand	AT	3.87 ★
				AT/PIT	3.87
3.2 mm OD x 12.2 mm	8GA Needle	50%	Injection	AT	6.02
				AT/PIT	5.95
	8GA Needle	30%	Hand	AT	3.87 ★
				AT/PIT	4.05
3.0 mm OD x 14.2 mm	9GA Needle	75%	Hand	AT	2.75 ★
				AT/PIT	2.74
	8GA Needle	50%	Injection	AT	5.38
				AT/PIT	5.38
HPT12 PIT	12GA Needle	75%	Injection	PIT	2.22

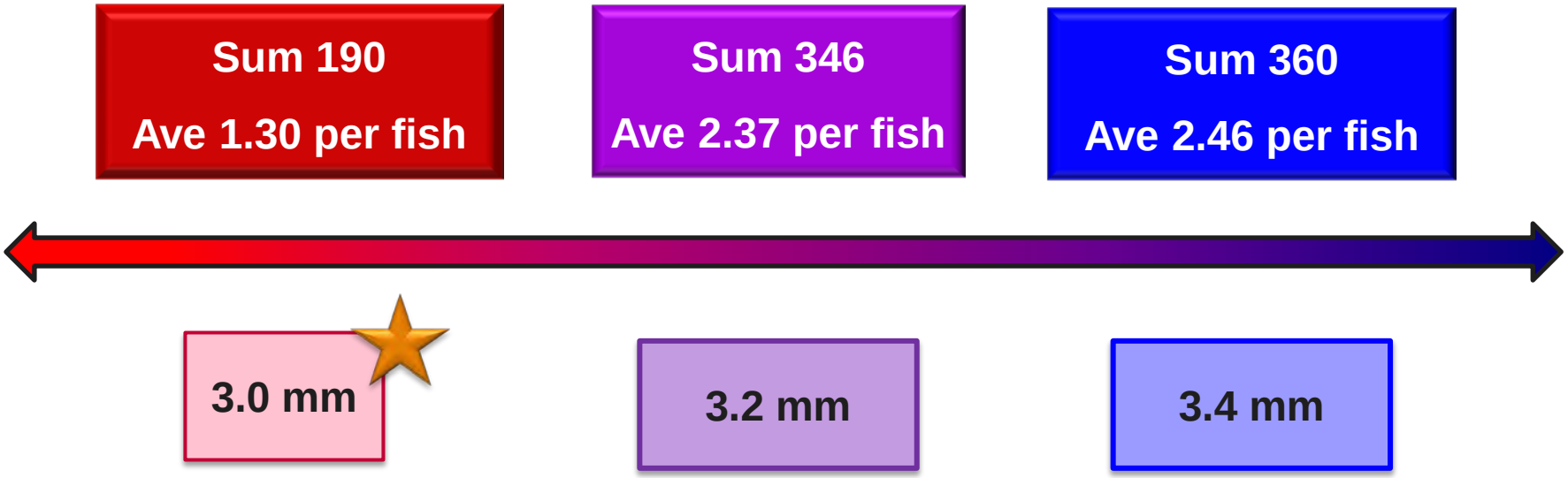
Results: Wound Extent by Day 14



-Pressure placed on fish flank changes with OD and bevel insertion

-Surgeon handling of needles

Results: Bio-Effects



- As AT increased injury, severity and frequency increased
- No organ damage
- Irritation and pressure necrosis present

Summary

- Survival
  - 100% within and among experiments
- Tag Retention
  - 100% within and among experiments
- Implantation Time
  - 1 tag is faster to load/implant than 2 tags
  - Smaller needles easier to handle and implant
    - 12 GA < **9 GA** < 8 GA < Occular
  - Recommendation: 3.0 mm

Summary

- Wound Extent
  - Day 0: 12 GA ~ **9 GA** ~ 8 GA 30% < 8 GA inject ~ OccScalpel
  - Day 14: 12 GA ~ **9 GA** < 8 GA 30% ~OccScalpel < 8 GA inject
  - Recommendation: 3.0 mm
- Bio-Effects
  - By Day 14- **3.0** < 3.2 ~ 3.4 mm
  - Reduced bio-effects compared to AT tags (2011, 2012)
  - Recommendation: 3.0 mm

<u>Final recommendation</u>

3 of 5 assessments

3.0 mm OD x 14.2 mm length

Relevance to Survival Studies

- No indications
  - AT or PIT moving out of injection point using 8 or 9 GA
  - External infections of 8 or 9 GA injection sites
  - Latent or delayed mortality from AT designs
- Reduced
  - Anesthetic exposure
  - Surgical times by min 50%
  - Overall time
- Increased efficacy
  - Fish health
  - Implantation and handling time
  - Costs

Next Steps…

- Testing
  - Rapid decompression exposure
  - Tag burden
  - Acoustic signal detection within fish
  - In-river survival
- Technique Development
  - Surgeon training
  - Maintenance of needle sharpness
  - Handling dual tags
    - Sterilization
    - AT activation and tag assignment

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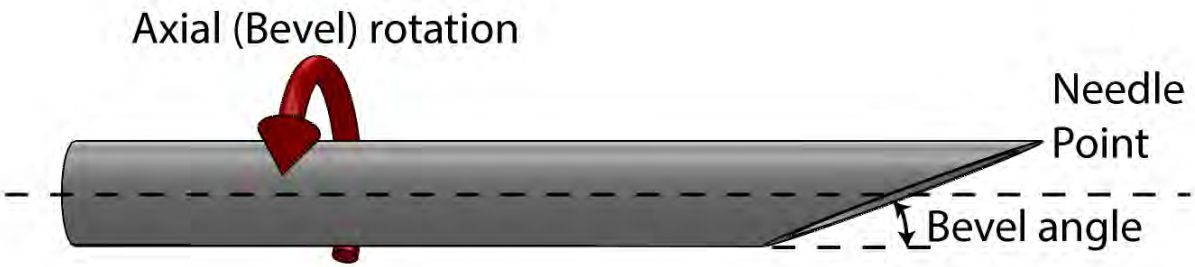
Background

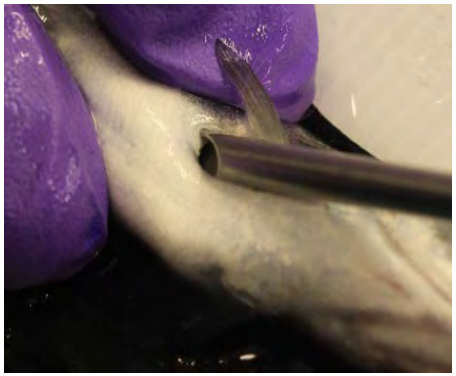
- **Criteria for downsized, injectable JSATS acoustic transmitters**
  - Reduce:
    - *handling and anesthesia* exposure
    - implantation *trauma* (externally and internally)
    - *wound extent* and healing time
  - *Maintain* high tag retention

Implantation: Techniques



0-degree rotation

90-degree rotation



180-degree rotation

- Tags drop
- Tended to slide down shaft premature